Geophysical Fluid Dynamics Laboratory
Laboratory Accomplishments

List 3-5 major accomplishments for your laboratory. If accomplishment occurred more than 2 years ago, cite recent progress. Please specify importance of accomplishment, who have been the major users and what has been the benefit to the taxpayer.

(1) Release of FMS

FMS is a software framework for supporting the efficient development, construction, execution, and scientific interpretation of atmospheric, oceanic and climate system models. FMS comprises a software infrastructure for constructing and running atmospheric, oceanic and climate system models. This infrastructure includes software to handle parallelization, input and output, time management, data exchange between various model grids, makefiles, and simple sample run scripts. This infrastructure largely insulates FMS users from machine-specific details. FMS has been used in the development of ocean models (MOM and HIM), and the new atmospheric and coupled climate models at GFDL. The Galway version of the FMS infrastructure was released to the research community on March 28, 2002, the Havana version on October 21, 2002, and the Inchon version in September, 2003.

(2) Ocean Model Development

Two new models of the worls ocean have been developed and released by GFDL scientists. The Modular Ocean Model (MOM) is a three-dimensional, z-coordinate, B-grid, primitive equation ocean circulation model. It is designed primarily as a tool for studying the ocean climate system. The Hybrid Isopycnal Model (HIM) is a three-dimensional, isopycnal coordinate, C-grid, primitive equation ocean circulation model. HIM is designed as a tool for studying both the ocean climate system and more idealized ocean circulations. Both models are developed and supported by researchers at NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) with contributions from oceanographers outside of GFDL. These models are currently being developed for use in GFDL's new coupled climate model.

(3) Hurricane Model Development

In May 2003, GFDL delivered to NCEP a new hurricane model to be used in its Hurricane Prediction System. The GFDL nested moveable mesh model is a primitive equation model formulated in latitude, longitude, and sigma coordinates, with 42 vertical sigma levels. It features improved representations of cumulus and boundary layer processes. Since 1995, the Hurricane Prediction System has provided operational guidance for forecasters at the National Hurricane Center (NHC) in both the Atlantic and East Pacific basins. In addition, a version of the GFDL model has been used by the Navy to provide operational guidance for storms in most of the other ocean basins. The hurricane model has been coupled to a high-resolution version of the Princeton Ocean Model. It is anticipated that sustained model improvements will continue to make the model a valuable tool to the National Hurricane Center.

(4) Ocean Data Assimilation

GFDL has continued its significant activities in Ocean Data Assimilation (ODA). These accomplishments include an extension of a 20-year global reanalysis that will be continually

kept up to date as an ongoing project. A software infrastructure has been developed for parallel computing environments. This has allowed for the integration of various methods for ocean state estimation and forecast initialization, including, ensemble methods, 4D-VAR and traditional OI. In particular, each of these methodologies is being developed with identical software for the handling of quality-controlled observational data streams, cost function evaluation, minimization and diagnostics. Current research is focused on the development of OI products for seasonal-to-interannual forecasting, including investigation of 3-dimensional prior variances, bias error modeling (with IRI and Jim Carton at University of Maryland) and reduced state space error models (with IRI). An assessment of the TAO moored observational network is being made in the context of seasonal forecast initialization using traditional OI methods as part of the ODASI partnership.

(5) Coupled Climate Modeling

GFDL has recently completed the configuration of its new atmospheric model and is nearing completion of its new coupled climate model. Comprised of GFDL's new atmosphere, land, ice, and the new MOM4 ocean models, this coupled model has significantly improved representations of the physical processes that govern the state of the Earth's climate. In addition to several thousand model years of experiments performed in support of the next IPCC assessment, the new coupled model will be used extensively to support the goals of the Climate Change Science Program, which include producing climate projections for research and assessment based on emission scenarios developed through the Climate Change Technology Program (in addition to the IPCC). An analysis of the climate models' sensitivity, feedbacks, and uncertainty will also be undertaken. Moreover, these results can be used to supply the best scientific information on climate change to policymakers, including information on the consequences of different technological options for producing energy.